

What is claimed is:

1. A piezoelectric device for an injector, built into an injector and generating driving force of said injector, characterized in that:

5 said piezoelectric device is fabricated by alternately laminating a plurality of piezoelectric layers generating displacement in proportion to an applied voltage and a plurality of internal electrode layers for supplying the applied voltage; and

10 in said piezoelectric device, a relation $d(0.1Ec)/d(1.2Ec) > 0.43$ is established, where Ec is coercive electric field which causes the changing of polarizing direction, between an apparent piezoelectric constant $d(1.2Ec)$ calculated from static elongation when an electric field of 1.2 Ec is applied to said piezoelectric device in the same direction as a polarizing direction while a preset load of 500 N is applied to said piezoelectric device, and an apparent piezoelectric constant $d(0.1Ec)$ calculated from static elongation when an electric field of 0.1 Ec is applied to said piezoelectric device in the same direction as the polarizing direction.

15 2. A piezoelectric device for an injector according to claim 1, wherein a relation

20 25 $d(0.1Ec)/d(1.2Ec) \geq 0.5$ is established between said piezoelectric constant $d(1.2Ec)$ and said piezoelectric constant $d(0.1Ec)$.

25 30 3. A piezoelectric device for an injector, built into an injector and generating driving force of said injector, characterized in that:

30 said piezoelectric device is fabricated by alternately laminating a plurality of piezoelectric layers generating displacement in proportion to an applied voltage and a plurality of internal electrode layers for supplying the applied voltage; and

35 said piezoelectric device has a change ratio of displacement of 9% or below when a frequency of

the applied voltage is changed from 1 Hz to 200 Hz under the state where an AC voltage is applied so that an electric field intensity of 0 to 1.5 kV/mm is generated by a sine wave while a preset load of 500 N is applied to
5 said piezoelectric device.

4. A piezoelectric device for an injector according to claim 1, wherein said change ratio of displacement is 7% or below.

10 5. A piezoelectric device for an injector, built in an injector and generating driving force of said injector, characterized in that:

15 said piezoelectric device is fabricated by alternately laminating a plurality of piezoelectric layers generating displacement in proportion to an applied voltage and a plurality of internal electrode layers for supplying the applied voltage; and

in said piezoelectric device, displacement increases with the rise of temperature within the range of -40°C to 150°C.

20 6. A piezoelectric device for an injector according to claim 5, wherein said change ratio of displacement is 5 to 40% within the range of temperature of -40°C to 150°C.

25 7. A piezoelectric device for an injector, built in an injector and generating driving force of said injector, characterized in that:

30 said piezoelectric device is fabricated by alternately laminating a plurality of piezoelectric layers generating displacement in proportion to an applied voltage and a plurality of internal electrode layers for supplying the applied voltage; and

said piezoelectric device has a dielectric loss of 8% or below calculated from a P-E hysteresis.

35 8. A piezoelectric device for an injector according to claim 7, wherein said dielectric loss is 7% or below.

9. A piezoelectric device for an injector built in

an injector and generating driving force of said injector, characterized in that:

5 said piezoelectric device is fabricated by alternately laminating a plurality of piezoelectric layers expanding and contracting in proportion to an applied voltage and a plurality of internal electrode layers for supplying the applied voltage;

10 the sectional shape of said piezoelectric device crossing at right angles the laminating direction is an octagon or a polygon with a larger number of sides than octagon; and

15 said piezoelectric device is accommodated in a cylindrical accommodation space.

10. A piezoelectric device for an injector according to claim 9, wherein a proximity ratio expressed by $(B/A) \times 100$ (%), where A is a length of the whole circumference of a circumscribed circle of said piezoelectric device and B is the sum of length of circumferential portions having a distance of 0.2 mm or below between said circumscribed circle and said piezoelectric device, is larger than 17%.

15. A piezoelectric device for an injector according to claim 9, wherein a proximity ratio expressed by $(B/A) \times 100$ (%), where A is a length of the whole circumference of a circumscribed circle of said piezoelectric device and B is the sum of length of circumferential portions having a distance of 0.2 mm or below between said circumscribed circle and said piezoelectric device, is 32% or more.

20 12. A piezoelectric device for an injector according to claim 9, wherein at least two side surface flat portions having a width of 2.5 mm or more are disposed on a side surface parallel to said laminating direction.

25 13. A piezoelectric device for an injector according to claim 9, wherein an insulating film having a thickness of 0.002 to 0.5 mm is formed at least on the

surface of a side surface parallel to the laminating direction.

14. A piezoelectric device for an injector according to claim 13, wherein a value $R_2 - R_1$, where R_1 is a maximum outer diameter of said piezoelectric device inclusive of said insulating member and R_2 is an inner diameter of said circular cylindrical accommodation space, is 0.5 mm or below.

10 15. A piezoelectric device for an injector according to claim 13, wherein said insulating film is made of any of a silicone resin, a polyimide resin, an epoxy resin and a fluorocarbon resin.

15 20. A piezoelectric device for an injector according to claim 9, wherein electrode take-out portions electrically connected to said internal electrode layers are disposed on a distal end face and a rear end face of said piezoelectric device in the laminating direction, respectively.

20 25. A piezoelectric device for an injector according to claim 9, wherein two electrode take-out portions electrically connected to said internal electrode layer are disposed on either one of a distal end face and a rear end face of said piezoelectric device in the laminating direction.

25 30. A piezoelectric device for an injector according to claim 16, wherein at least one of said electrode take-out portions is electrically connected to at least one of said internal electrode layers through a through-hole formed in said piezoelectric layer.

30 35. A piezoelectric device for an injector according to claim 16, wherein at least one of said electrode take-out portions is electrically connected to a side surface disposed on said side surface of said piezoelectric device.

35 40. A piezoelectric device for an injector built in an injector and generating driving force of said injector, characterized in that:

5 said piezoelectric device is fabricated by alternately laminating a plurality of piezoelectric layers expanding and contracting in proportion to an applied voltage and a plurality of internal electrode layers for supplying the applied voltage;

 at least a part or the whole of the sectional shape of said piezoelectric device crossing at right angles the laminating direction is arcuate; and

10 said piezoelectric device is accommodated in a circular cylindrical accommodation space.

15 21. A piezoelectric device for an injector according to claim 20, wherein a proximity ratio expressed by $(B/A) \times 100$ (%), where A is a length of the whole circumference of a circumscribed circle of said piezoelectric device and B is the sum of length of circumferential portions having a distance of 0.2 mm or below between said circumscribed circle and said piezoelectric device, is larger than 17%.

20 22. A piezoelectric device for an injector according to claim 20, wherein a proximity ratio expressed by $(B/A) \times 100$ (%), where A is a length of the whole circumference of a circumscribed circle of said piezoelectric device and B is the sum of length of circumferential portions having a distance of 0.2 mm or below between said circumscribed circle and said piezoelectric device, is 32% or more.

25 23. A piezoelectric device for an injector according to claim 20, wherein at least two side surface flat portions having a width of 2.5 mm or more are disposed on the side surface parallel to the laminating direction.

30 24. A piezoelectric device for an injector according to claim 20, wherein an insulating film having a thickness of 0.002 to 0.5 mm is formed on at least the surface of the side surface parallel to the laminating direction of said piezoelectric device.

 25. A piezoelectric device for an injector

according to claim 24, wherein a value $R_2 - R_1$, where R_1 is a maximum outer diameter of said piezoelectric device inclusive of said insulating member and R_2 is an inner diameter of said cylindrical accommodation space, is 0.5 mm or below.

5 26. A piezoelectric device for an injector according to claim 24, wherein said insulating film is made of any of a silicone resin, a polyimide resin, an epoxy resin and a fluorocarbon resin.

10 27. A piezoelectric device for an injector according to claim 20, wherein electrode take-out portions electrically connected to said internal electrode layers are disposed on a distal end face and a rear end face of said piezoelectric device in the laminating direction, respectively.

15 28. A piezoelectric device for an injector according to claim 20, wherein two electrode take-out portions electrically connected to said internal electrode layer are disposed on either one of a distal end face and a rear end face of said piezoelectric device in the laminating direction.

20 29. A piezoelectric device for an injector according to claim 27, wherein at least one of said electrode take-out portions is electrically connected to at least one of said internal electrode layers through a through-hole formed in said piezoelectric layer.

25 30. A piezoelectric device for an injector according to claim 27, wherein at least one of said electrode take-out portions is electrically connected to a side surface disposed on said side surface of said piezoelectric device.